



Editorial

Untapping the Potential of Neglected and Underutilized Species to Improve Food Security

David Draper ^{1,2,*} and Isabel Marques ^{3,*}

¹ Center for Ecology, Evolution and Environmental Changes & CHANGE—Global Change and Sustainability Institute, Universidade de Lisboa, 1649-028 Lisbon, Portugal

² Nova School of Business and Economics, Campus de Carcavelos, Universidade Nova de Lisboa, 2775-405 Carcavelos, Portugal

³ Forest Research Centre (CEF) & Associate Laboratory TERRA, Instituto Superior de Agronomia (ISA), Universidade de Lisboa, 1349-017 Lisbon, Portugal

* Correspondence: ddmunt@gmail.com (D.D.); isabelmarques@isa.ulisboa.pt (I.M.)

World food production will need to increase by at least 50% to meet our future needs [1]. Environmental changes, along with current agricultural practices, will further pose significant challenges to food security, especially in developing countries [2]. Neglected, minor and underused crops could help mitigate this threat [3], demonstrating the potential for becoming a game-changer if research is conducted on their development. This Special Issue presents recent signs of progress toward the potential use of orphan crops to contribute to food security, addressing novel genetic, agronomic, and molecular results, necessary for the uptake of these species as novel future crops.

Cereals are rich sources of nutrients, both for humans and animals. The finger millet (*Eleusine coracana* (L.) Gaertn.), one of the minor cereals, is known for several health benefits, being a subsistence crop in many semiarid regions of the world. However, there is a need to identify desirable functional characteristics, and quantify the nutritional importance of this crop. Ref. [4] tackles this aim by quantifying the forage quality and diversity of 314 finger millet accessions from 23 different countries. They showed that the forage quality this crop is higher than rice or wheat, being even comparable with sorghum and pearl millet. These results can be applied to identify promising lines useful to develop elite cultivars with improved forage quality traits.

Another minor cereal, extensively cultivated by small-scale farmers in the Horn of Africa, is tef (*Eragrostis tef* (Zucc.) Trotter). Although tef provides high-quality foods and grows under conditions unsuitable for many cereal crops, it still shows a very low productivity. Ref. [5] characterizes the productivity of 317 tef genotypes and 3 improved cultivars, as well as the influence of intensive and conventional agronomic management practices. The results showed a high variability in grain yield, biomass, harvest index, and phenological traits, which could be used to further improve tef through desirable trait recombination and selection. Among the studied traits, the grain-filling period showed the highest genetic coefficient of variation in plants grown under intensive conditions, suggesting strong implications between the type of land management and the productivity of tef.

Legumes are a major protein source for most consumers. Native to Africa, cowpea (*Vigna unguiculata* (L.) Walp.) is a minor crop that has shown high potential to contribute to food and nutrition security. A large proportion of smallholder farmers rely on traditional cowpea landraces, which are thought to be a reservoir of diversity, although their characterization is often lacking. Ref. [6] categorized the morphological attributes of 61 cowpea genotypes in 10 landraces across six agroecological zones, and three provinces in Mozambique. They showed a remarkably high level of morphological diversity across landraces, suggesting that the country is a hotspot for cowpea diversity. This diversity is important for the foundation of successful cowpea breeding programs.



Citation: Draper, D.; Marques, I. Untapping the Potential of Neglected and Underutilized Species to Improve Food Security. *Agronomy* **2022**, *12*, 3138. <https://doi.org/10.3390/agronomy12123138>

Received: 25 November 2022

Accepted: 5 December 2022

Published: 10 December 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Lupinus mutabilis (tarwi) has played an important role in the high Andean production systems since the Inca period, being highly valued for its high protein and oil content of its seeds, which can vary in color. Anthocyanins often control these colors in legume seeds and, therefore, it would be important to understand how they are expressed, as seed colors influence consumer preferences. To fill this important gap, ref. [7] identifies the levels of expression of the flavanone 3-hydroxylase (*F3H*) gene, central to the flavonoid biosynthetic pathway. They identified two putative paralogues of the *LmF3H* gene (*LmF3h_a* and *LmF3h_b*) in brown seeds and one in white seed coats (*LmF3h_a*), with *LmF3h_a* being overexpressed in brown seeds. This provided an important basis for developing molecular markers that can be used in breeding programs, as the seed coat color is not an easily genetically tractable trait in tarwi.

Taro (*Colocasia esculenta* (L.) Schott) is one of the world's oldest used tuber crops, being a staple food for many families in the tropics and subtropics. However, this crop is experiencing a significant decline due to many diseases, including the taro leaf blight caused by the fungus *Phytophthora colocasiae*. Ref. [8] reviews the factors that limit the production of this minor crop, providing insights on available technologies that could help enhance the sustainability of this crop. Genetic tools that could boost taro breeding have been scarcely used. The genotyping of germplasm collections, marker-assisted selection, and genome-wide associations are needed in taro breeding programs to enhance the productivity of this crop.

Climate change is constraining crop production globally, including major crops such as coffee. Ensuring a steady supply requires understanding the impacts of adverse climate conditions and the use of minor genotypes that can better cope with changes. To understand which coffee phenotypic traits can better tolerate adverse environmental conditions, ref. [9] studied the variability of leaf morphoanatomical traits in 43 genotypes of *Coffea canephora* Pierre ex A. Froehner. They showed a wide heterogeneity within genotypes, although some possessed traits, such as the number and width of stomata, which could be potentially important in enhancing tolerance under adverse climatic conditions. Thus, these traits can be exploited in future breeding cultivars to adapt the *C. canephora* crop to a broader range of environmental conditions.

Achieving crop tolerance to environmental changes via modern breeding techniques while exploiting the natural variation in underutilized crops and genotypes is an excellent way to accomplish food requirements. Nonetheless, this is often constrained by a lack of knowledge regarding the molecular pathways involved in such variation and in tolerance potentials. To better understand the effects of drought, ref. [10] studied the transcriptome responses of two minorly used coffee cultivars, *Coffea canephora* cv. CL153 and *Coffea arabica* cv. Icatu, grown under moderate or severe water deficits. Even though drought had an impact on the leaf transcriptome of those genotypes, the results showed that they were more resistant than other widely used coffee cultivars, especially under moderate drought levels. Many desiccation-protectant genes, including aspartic proteases, transcription factors, phosphatases and protein kinases, are involved in drought responses in these genotypes, which could be used in coffee breeding programs for the selection of elite climate-tolerant genotypes.

Finally, in recent years, agroforestry systems have become increasingly recognized as valuable tools for food security, while reinforcing economic, social, and environmental benefits. However, the design of agroforestry systems, the choice of shade trees and the type of planting crops are often limiting factors. Ref. [11] addressed this gap by assessing if tuber crops, such as the arrowroot (*Maranta arundinacea* L.), canna (*Canna edulis* Kerr), and yam (*Dioscorea esculenta* (Lour.) Burkill), could be cultivated under high-density teak (*Tectona grandis* L.f.) plantations. They showed that teak trial areas were suitable for canna production, while other management options would be needed for arrowroot and yam production. Canna could be used in mixed teak agroforestry systems with low-intensity light. Land optimization using shade-resistant tubers was proposed to offer medium-term benefits if proper silvicultural procedures were to be applied.

Altogether, these studies show several potential approaches for assuring the future of food security. Systematic efforts concerning socioeconomic, political, and policy changes facilitating the adoption of these crops would be crucial for improving food and nutritional security in the context of climate change.

Author Contributions: Conceptualization, D.D., I.M.; writing—original draft preparation, D.D., I.M.; writing—review and editing, D.D., I.M.; project administration, D.D., I.M.; funding acquisition, D.D., I.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received national funds through the FCT—Fundação para a Ciência e a Tecnologia, I.P., Portugal through the research unit UIDB/00329/2020 (CE3C), UIDB/00239/2020 (CEF), and under the Scientific Employment Stimulus—Individual Call (CEEC Individual)—2021.01107.CEECIND/CP1689/CT0001 (IM).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. van Dijk, M.; Morley, T.; Rau, M.L.; Saghai, Y. A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050. *Nat. Food* **2021**, *27*, 494–501. [[CrossRef](#)]
2. Bozsik, N.; Cubillos, J.P.T.; Stalbek, B.; Vasa, L.; Magda, R. Food security management in developing countries: Influence of economic factors on their food availability and access. *PLoS ONE* **2022**, *17*, e0271696. [[CrossRef](#)] [[PubMed](#)]
3. Raj, S.; Roodbar, S.; Brinkley, C.; Wolfe, D.W. Food Security and Climate Change: Differences in Impacts and Adaptation Strategies for Rural Communities in the Global South and North. *Front. Sustain. Food Syst.* **2022**, *5*, 264. [[CrossRef](#)]
4. Backiyalakshmi, C.; Babu, C.; Reddy, D.N.; Padmakumar, V.P.; Prasad, K.V.S.V.; Azevedo, V.C.R.; Vetriventhan, M. Assessing forage potential of the global collection of finger millet (*Eleusine coracana* (L.) Gaertn.) conserved at the ICRISAT genebank. *Agronomy* **2021**, *11*, 1706. [[CrossRef](#)]
5. Bayable, M.; Tsunekawa, A.; Haregeweyn, N.; Alemayehu, G.; Tsuji, W.; Tsubo, M.; Adgo, E.; Tassew, A.; Ishii, T.; Asaregew, F.; et al. Yield Potential and Variability of Teff (*Eragrostis tef* (Zucc.) Trotter) Germplasms under Intensive and Conventional Management Conditions. *Agronomy* **2021**, *11*, 220. [[CrossRef](#)]
6. Gomes, A.M.F.; Draper, D.; Nhantumbo, N.; Massinga, R.; Ramalho, J.C.; Marques, I.; Ribeiro-Barros, A.I. Diversity of cowpea [*Vigna unguiculata* (L.) walp] landraces in Mozambique: New opportunities for crop improvement and future breeding programs. *Agronomy* **2021**, *11*, 991. [[CrossRef](#)]
7. Guilengue, N.; Azinheira, H.G.; Alves, S.; Neves-Martins, J.; Talhinhas, P.; Morais-Cecílio, L. The Analysis of Partial Sequences of the Flavonone 3 Hydroxylase Gene in *Lupinus mutabilis* Reveals Differential Expression of Two Paralogues Potentially Related to Seed Coat Colour. *Agronomy* **2022**, *12*, 450. [[CrossRef](#)]
8. Oladimeji, J.J.; Kumar, P.L.; Abe, A.; Vetukuri, R.R.; Bhattacharjee, R. Taro in West Africa: Status, Challenges, and Opportunities. *Agronomy* **2022**, *12*, 2094. [[CrossRef](#)]
9. Dubberstein, D.; Oliveira, M.G.; Aoyama, E.M.; Guillen, J.H.; Ferreira, A.; Marques, I.; Ramalho, J.C.; Partelli, F.L. Diversity of leaf stomatal traits among *Coffea canephora* pierre ex A. Froehner genotypes. *Agronomy* **2021**, *11*, 1126. [[CrossRef](#)]
10. Fernandes, I.; Marques, I.; Paulo, O.S.; Batista, D.; Partelli, F.L.; Lidon, F.C.; Damatta, F.M.; Ramalho, J.C.; Ribeiro-Barros, A.I. Understanding the impact of drought in *Coffea* genotypes: Transcriptomic analysis supports a common high resilience to moderate water deficit but a genotype dependent sensitivity to severe water deficit. *Agronomy* **2021**, *11*, 2255. [[CrossRef](#)]
11. Maharani, D.; Sudomo, A.; Swestiani, D.; Murniati; Sabastian, G.E.; Roshetko, J.M.; Fambayun, R.A. Intercropping Tuber Crops with Teak in Gunungkidul Regency, Yogyakarta, Indonesia. *Agronomy* **2022**, *12*, 449. [[CrossRef](#)]